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Description

Energy-saving device for a rail vehicle

The invention relates to a device for a rail vehicle having a control unit which determines a distance value specifying the distance of the rail vehicle from the respectively provided, next stopping point using a measured location measured value specifying the location of the rail vehicle and predefined, stored route data, determines the remaining time to the next stopping point using a measured time measured value specifying the respective time, and a predefined, stored timetable, and calculates a deactivation time taking into account the distance value which is determined, the remaining travel time which is determined, a speed measured value which specifies the speed of the rail vehicle and predefined coasting data which describe the coasting behavior of the rail vehicle when the drive is deactivated, starting from which deactivation time the rail vehicle promptly reaches, in a non-driven fashion, the next stopping point which is respectively provided according to the timetable, while complying with the timetable, and an output device which is connected to the control unit, is actuated by it and generates a deactivation signal specifying the deactivation time.

Such a device is known from US patent 5,239,472 and is used to make a saving in travel energy on rail vehicles. This device has, as control unit, a microprocessor which determines the distance between the rail vehicle and the respective next stopping point with a location measured value which is sensed by an odometer and with route data which is stored in storage means.

Furthermore, the microprocessor determines, with a

measured time measured value which indicates the respective time, and with a predefined, stored timetable, the travel time remaining to the rail vehicle until it reaches the next stopping point. With the distance value and the remaining travel time, the microprocessor then calculates, while taking into account the respective travel speed and the coasting behavior of the rail vehicle, that point in time (referred to below as deactivation time) - starting from which the rail vehicle can reach the respective next stopping point in non-driven fashion - that is to say by coasting or in a braked fashion - while complying with the timetable. An output device in the form of a display device is connected to the control unit. The display device is actuated by the control unit in such a way that by displaying the term "coast" it signals from which time the drive of the rail vehicle can be switched off. In the previously known device, the route data and the predefined timetable are transmitted to the rail vehicle by a track-mounted computing unit before the rail vehicle is put into operation, and are permanently stored in said computing unit. The previously known device is therefore, in summary, an energy-saving device which indicates from what time the next stopping point can be reached in accordance with the timetable in a non-driven fashion and thus without consuming energy by utilizing the respective kinetic energy of the rail vehicle.

The invention is based on the object of developing a device of the type described at the beginning in such a way that a reliable saving in travel energy can be achieved with it even when there are operating faults.

This object is achieved according to the invention with a device of the type described at the beginning by virtue of the fact that the invention has a data input at which a timetable modification variable can be input

into the device, and the control unit is configured in such a way that, if a timetable modification variable is input, it forms a modified timetable with the predefined, stored timetable and the timetable modification variable which is input, and forms the remaining travel time and the deactivation time taking into account the modified timetable instead of the stored timetable.

An essential advantage of the device according to the invention is that the latter also reliably specifies the correct time for the switching off of the drive even if it is not possible to comply with the timetable owing to operational faults - for example in the case of track faults such as "congestion" on the route or in the case of failures of vehicles etc. The device according to the invention specifically has, in contrast to the previously known device, a data input at which a timetable modification variable can be input into the device according to the invention with the result that when there are operational faults, it is possible, for example, for timetable modifications to be input to the device by a track-mounted device, for example by radio. In order to process this timetable modification variable, the control unit of the device according to the invention is configured in such a way that it forms a modified timetable with the predefined stored timetable and the timetable modification variable which is input, and forms the remaining travel time and the deactivation time of the drive taking into account this modified timetable. In summary, with the device according to the invention it is therefore possible to take into account changes in the timetable by feeding into the device a corresponding timetable modification variable so that, in contrast to the previously known device, a saving in travel energy can be reliably obtained with the device according to the invention even when there are operational faults. A

further significant advantage of the device according to the invention is that, in order to input the changes in the timetable, only one timetable modification variable has to be input into the device; it is therefore not necessary to transmit a complete new timetable to the rail vehicle or to the device according to the invention. This will be explained with reference to an example: if a fault has occurred on a route - for example as a result of congestion on the route - the originally stored timetable can, under certain circumstances, no longer be complied with and it must be replaced by a new timetable. Because a timetable comprises a multiplicity of data, and thus a large quantity of data, this large quantity of data would generally have to be transmitted to the rail vehicle so that the device or the control unit can determine the deactivation time of the drive taking into account this new timetable. In the device according to the invention, the transmission of a complete new timetable data record is, however, not necessary because with the device according to the invention only a timetable modification variable has to be transmitted to the device. If it is possible to calculate at the track end - for example in the case of congestion - that the timetable is shifted by a total of approximately $\Delta t = +10$ minutes, a track-mounted device is used, for example, to merely transmit a timetable modification variable of $\Delta t = +10$ minutes to the rail vehicle or to the device according to the invention, and a modified timetable is formed in the device or in the control unit using the predefined, permanently stored timetable and the timetable modification variable of $\Delta t = +10$ minutes. The remaining travel time and the deactivation time for the drive is then formed in the control unit taking into account this modified timetable.

The modified timetable can be particularly easily

formed in the control unit by adding the timetable modification variable to each individual predefined time information item of the stored timetable. With this progression of the method according to the invention, the timetable modification variable is added with the correct sign to the respective predefined time information item of the stored timetable; this ensures that both changes to the timetable which bring about a prolongation of the travel time and changes to the timetable which cause a reduction in the travel time can be taken into account; this latter case is significant, for example, if, contrary to the information specified in the stored timetable, the rail vehicle is to reach the respective next stopping point earlier than originally provided so that the route is cleared earlier than planned.

In order to achieve overall short travel times of the rail vehicle, it is generally necessary to avoid the rail vehicle coming to a standstill exclusively by coasting to the stopping point because specifically coasting at a very low speed can, under certain circumstances, take a long time. For this reason, the rail vehicle is generally braked according to a predefined braking profile when it reaches a minimum speed. In order to allow for this fact, according to one development of the device according to the invention there is provision for the control unit to be configured in such a way that it determines the deactivation time while additionally taking into account a predefined braking profile and a predefined minimum speed, on whose downward transgression the rail vehicle is braked in the phase of the non-driven travel toward the next stopping point in accordance with the predefined braking profile. In order to explain the invention, a figure shows an exemplary embodiment of a device according to the invention.

The figure shows a device 5 for a rail vehicle (not illustrated) with a control unit 10 which is connected by its one input E10A to a measuring device 15. The measuring device 15 can be, for example, what is referred to as an odometer which determines the respective speed of the rail vehicle and the distance which has already been respectively covered, and thus the respective location S of the rail vehicle, using the revolutions of the wheels of the rail vehicle. At a further input E10B of the control unit 10, a timer in the form of a clock 20 which transmits the respective time t as a time measured value to the control unit 10 is arranged upstream of the control unit 10.

An additional input E10C of the control unit 10 is connected to a storage means 25 in which route data and a binding timetable for the rail vehicle are permanently stored. Furthermore, coasting data AD which describe the coasting behavior of the rail vehicle when the drive is deactivated are stored in the storage means 25; this coasting data AD can be, for example, deceleration values which have been measured in advance when the rail vehicle coasts, that is to say when the drive is deactivated.

The control unit 10 also has a supplementary input E10D at which a timetable modification variable Δt in the form of a time offset value can be applied to the control unit. The supplementary input E10D of the control unit 10 simultaneously forms a data input E5 of the device 5.

An output device 30 is arranged downstream of the control unit 10 at an output A10.

The device 5 is operated as follows:

Firstly the measuring device 15 and the clock 20 are

interrogated with the control unit 10; a location measured value S specifying the respective location of the rail vehicle, a speed measured variable V specifying the respective speed of the rail vehicle and a time measured value t specifying the respective time are transmitted to the control unit 10 here.

The control unit 10 subsequently reads the location S0 of the respective next stopping point and a scheduled arrival time t0 from the storage means 25 as route information or route data; the scheduled arrival time t0 specifies here the time at which the rail vehicle should have reached the respective next stopping point. In addition, the control unit 10 interrogates the coasting data AD stored in the storage means 25.

The control unit 10 then tests whether a timetable modification variable Δt is present at its supplementary input E10D. The application of a timetable modification variable Δt to the supplementary input E10D can be carried out in different ways, with the result that the supplementary input E10D can be configured, for example, in such a way that a timetable modification variable Δt can be made electrically by means of a keypad input of the vehicle driver. Another method of inputting the timetable modification variable Δt could be for the timetable modification variable Δt to be fed into the computing unit 10 by radio - for example by means of a track-mounted device; this would then of course require corresponding receiving antennas at the supplementary input E10D of the computing unit.

It is assumed below, by way of example, that a timetable modification variable $\Delta t = + 10$ minutes is applied to the supplementary input E10D of the control unit 10.

The control unit 10 subsequently forms a modified

timetable by adding the timetable modification variable $\Delta t = + 10$ minutes to each individual predefined timetable information item stored in the storage means 25; this addition will now be explained by reference to the example of the scheduled arrival time t0, with which a modified scheduled arrival time t0' is formed according to:

$$t0' = t0 + \Delta t$$

Then, this modified scheduled arrival time t0', the location measured value S, the location S0 of the next stopping point, the speed V and the coasting data AD of the rail vehicle are used to determine a deactivation time from which the rail vehicle reaches the next stopping point with the drive deactivated by using its kinetic energy and while keeping to the modified timetable.

In order to achieve short travel times of the rail vehicle overall, it is generally necessary to avoid the rail vehicle coming to a standstill at the stopping point exclusively as a result of coasting because specifically under certain circumstances the coasting can take a long time at very low speeds. For this reason, the rail vehicle is generally braked in accordance with a predefined braking profile when a predefined minimum speed is downwardly transgressed. In order to allow for this fact, it is also possible to provide for the deactivation time in the computing unit 10 to be determined while additionally taking into account the predefined braking profile and the predetermined minimum speed.

The way in which the deactivation time can be determined using these input parameters - that is to say the scheduled arrival time t0', the location measured value S, the location S0 over the next

stopping point, the speed V and the coasting data AD as well as, if appropriate, a possibly predefined minimum speed and a possibly predefined braking profile - can be found in detail in US patent 5,239,472 mentioned at the beginning; the content of this US patent 5,239,472 is therefore a component of this description.

After the deactivation time has been determined, the control device 10 forms an actuation signal ST for the output device 30; the output device 30 then generates a deactivation signal which specifies the deactivation time. This deactivation signal can be, for example as in the previously known device explained at the beginning, a visual display which signals, by displaying the term "coast" that the coasting can be started; instead, it can also be a display which displays or indicates the deactivation time visually and/or audibly in the form of time information.